ART. X.—*Ligation of the Axillary Artery in the First Portion of its Course.* By JOHN H. BRINTON, M. D., of Philadelphia.

THE ligation of the axillary artery in its continuity has been frequently performed during the late war, for the arrest of hemorrhage following gunshot wounds, and after amputation. In most of the instances reported the ligation of the vessel has been effected low down in the axilla, below the point at which it is crossed by the pectoralis minor muscle. The artery is here superficially placed, and can usually be exposed and tied with comparative ease and certainty.

But cases have occasionally occurred, one or two of which the writer has witnessed, in which the ligature of the axillary in the lower portion of its course has proved to be a matter of impossibility, owing to a lacerated or sloughing condition of the part, or to the excessive extravasation of blood. Under such circumstances, a departure from Mr. Guthrie's excellent rule of ligating a wounded artery at its point of injury has been warranted, and the operation of tying the subclavian or the axillary artery in its continuity in the first portion of its course, has been resorted to. Most generally military surgeons have preferred to attack the subclavian rather than the axillary above the pectoralis minor. This indisposition to attempt the ligature of the latter vessel at the point indicated is probably based on its deep-seated position, its complicated relations, and the liability of failure to reach and successfully isolate it; a failure which may occur at the hands of experienced operators. That the uncertainty of this operation is not overestimated will be evident when it is remembered that even so skilled a master in surgery as Dupuytren himself, occupied forty minutes in his search for the vessel, and only succeeded in finding it after the application of twelve or thirteen ligatures on the smaller arteries.

Before alluding to the methods usually employed to find the axillary artery in the first position of its course, it will be well to glance for a moment at its anatomical relations. It will be remembered that this vessel, the continuation of the subclavian, extends from the lower margin of the first rib to the lower border of the axilla, as indicated by the inferior margins of the pectoralis major and latissimus dorsi muscles. Its course from its commencement to its termination in the brachial is slightly curved, and the point at which it passes from beneath the clavicle when the latter is in the horizontal position is about the middle of the middle third of the bone. In its progress through the axilla the artery is crossed by the pectoralis minor muscle, which divides it into three portions; the first *above* the muscle, the second *behind*, and the third *below* it. In the first portion of its course the artery rests in a triangle, the subclavicular, which is bounded above by the clavicle, below and externally by the upper border of the pectoralis minor, and below and internally by the upper border of the sternal portion of the pectoralis major. Externally and posteriorly to the artery rest the branches of the axillary plexus of nerves, and internally and nearer to the sternum the great axillary vein, which when distended with blood during expiration somewhat covers the artery. The cephalic vein, emerging from the intermuscular space between the deltoid and the clavicular portion of the pectoralis major muscle, crosses the apex of the subclavicular triangle and empties into the axillary vein in front of the artery. The tissues which cover the axillary artery in the first portion of its course are the skin and superficial fascia, with some fibres of the platysma-myoid muscle, the pectoralis major muscle, more especially its clavicular portion arising from the inner third of the clavicle, the costo or coraco-clavicular membrane which stretches from the upper border of the pectoralis minor to the subclavius muscle, and loose cellular tissue.

The methods laid down in the books and usually employed for the ligation of the axillary are the following :—

First, That which is known as the *ordinary* process, which consists of a straight incision parallel to and about one-half of an inch below the clavicle. This incision is continued down, the pectoralis major muscle being divided in its track until the artery is reached. The objections to this process are the limited room afforded to the search of the operator, and the obscurity which results from the hemorrhage from the vessels divided in the incision through the muscle and which are not readily tied.

Second, Hodgson's operation, consisting of a semilunar incision, convex downwards below the clavicle, involving about the same extent of surface as the ordinary process. This method answers well enough on the cadaver, but on the living subject it would probably not sufficiently uncover the vessel to permit of its ligation with certainty. It would, moreover, be attended with considerable destruction of the muscle, and with hemorrhage from the smaller vessels.

Third, Lisfranc's operation. This surgeon advised a single incision directly over the interstice between the two portions of the pectoralis major muscle, the incision to be continued down through this interstice until the artery be found. As this procedure affords but scanty room for the operator's manipulation even on the cadaver, it would be scarcely advisable to attempt it upon the living patient.

Fourth, Chamberlayne's operation. This consists of a double incision, one horizontal and parallel to the clavicle, and the other passing from the outer angle of the first, along the muscular interspace existing between the deltoid and pectoralis major. By raising the flap thus exposed, the axillary artery can be reached below the pectoralis minor muscle.

Fifth, Keate's operation, in which an incision is made directly over the vessel obliquely outwards and downwards from the middle third of the clavicle. This process would appear to be open to the same objections as Lisfranc's operation, although to a less degree.

All of the procedures above alluded to for the ligation of the axillary artery in the first portion of its course, appeared to the writer to be from some cause or other objectionable and scarcely applicable upon the living subject. He therefore determined, early in the late war, that should he meet with a proper case for the ligation of the first portion of the axillary artery, he would avail himself of the method devised and published by Professor Pancoast, of Philadelphia.[1] From frequent practice upon the cadaver he felt assured that the operation of Pancoast could be readily performed with almost an absolute certainty of finding the vessel at the desired point without injury to the great nerves and veins, and without undue laceration of the soft parts. An opportunity for the performance of this operation presented itself to him in the summer of 1863, and as he has recently been informed by Dr. Pancoast that this was the first application upon the living subject of his process, the outlines of the case are herewith submitted.

M. H., a soldier, about thirty years of age, was wounded in the middle of the left arm, by a cylindro-conoidal bullet, during the first day's fight at the battle of Gettysburg. The arm was amputated on the field, just below the insertion of the pectoralis major. Two or three days subsequent to this operation the patient was admitted into one of the temporary hospitals established in the town of Gettysburg. Shortly after his admission the flaps sloughed to a considerable extent, and slight secondary hemorrhage occurred, which was arrested by pressure on the axilla. About the eighth day after the amputation the secondary hemorrhage recurred. An attempt was made by the medical officer in charge to ligate the axillary artery low down in the axilla, but owing to the disintegrated condition of the soft parts, and the local extravasation of blood, the effort was unsuccessful. The bleeding was then partially checked by renewed pressure in the axilla.

At this time I was first called in to see the patient. Much blood had already been lost; the condition of the soft parts on the inside of the arm, and in the lower part of the axilla was extremely bad. I did not consider it advisable to attempt further operative interference on the parts already implicated. As no time was to be lost I decided to ligate the axillary artery in the first portion of its course, according to the method proposed by Dr. Pancoast. The patient was accordingly laid upon his back, and the stump of the arm was carried outward by an assistant. An imaginary line was then drawn from the sterno-clavicular articulation to the lower border of the insertion of the pectoralis major muscle, so as to determine the position of the interspace between the clavicular and sternal portions of this muscle. Along this line an incision about four and a half inches long was made through the integuments, commencing about one inch external to the sterno-clavicular articulation. The interspace between the sternal and clavicular portions of the muscle, which was readily distinguished, was next opened with the handle of the knife, and the fascia on the posterior surface of the muscle was divided on a director. The fibres of the muscle were then relaxed by bringing the stump toward the body. An assistant was then directed to insert the forefinger of each hand beneath the clavicular portion of the muscle, pushing his fingers up as far as the clavicle. He was thus enabled to grasp and compress between his fingers and thumbs the muscle and integuments, which were then divided up to the centre of the clavicle by an incision perpendicular to the course of the muscular fibres. The space resulting from the incision and the consequent retraction of the divided ends of the muscle, was amply sufficient to allow the search for the vessel being conducted with certainty and rapidity. The hemorrhage, which was inconsiderable, was arrested by a single ligature before the divided muscle was released from the assistant's grasp. The strong fascia which stretches from the pectoralis minor to the subclavius was next raised with the forceps and carefully torn across, and the cellular tissue beneath gently broken up above the origin of the acromio-thoracic trunk. The axillary artery, which was feebly pulsating, was then readily isolated, and a ligature was thrown around it with the effect of instantly arresting the hemorrhage from the stump. The cephalic vein was not exposed during the steps of the operation, although by close examination its location could be discovered ; but neither it nor the axillary vein, which latter slightly overlapped the artery, were loosened from their cellular connections.

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[1] "Treatise on Operative Surgery," Philadelphia, 1846, p. 58, &c.

It should be here observed that in this operation the position assumed by the surgeon is important. He should stand, as was done in this case, above the patient's shoulder, and operate from above downwards. If he should stand below the shoulder he would instinctively, as it were, work towards himself, and most probably endanger the cephalic vein, if indeed he should not fall below the axillary vein. The writer has so often observed these results in operations upon the cadaver, in which the manipulator has stood in the objectionable situation, that he is led to regard the position which the operator should hold to his patient as a matter not to be overlooked.

The operation above described occupied certainly not more than three minutes in its performance, and was attended with no difficulty whatever. The exposure of the deep-seated parts by the second incision was complete, and the vessel was readily arrived at, and easily isolated without prolonged search or injurious handling of the parts. Nor were the large veins and nerves subjected to the contact of instruments or of the fingers.

It is to be regretted that the writer cannot add to the foregoing account a statement of a successful issue to this case. Unfortunately the result was otherwise. The patient did well for ten or twelve days, but eventually died of hemorrhage from the axillary artery at the point of ligature, occurring at the time of the separation of the thread.

The untoward result in this case does not, however, militate against the feasibility of the operation, which would appear to offer incontestable advantage over all of the ordinary processes for the ligation of the axillary artery in its upper portion ; and which must unquestionably be attended with less risk to life than the operation for the ligature of the subclavian.